The adjusted genomic relationships by allele frequencies within breeds and use in single-step GBLUP

- Simple allele frequencies (AF) across breeds are often used to construct genomic relationship matrix (G) in multi-breeds
- Ignoring differences in AF between breeds may result in distorted coefficients in G
- Optimal construction of G, and its incorporation with the numerator relationship matrix (A) may improve single-step GBLUP in multi-breeds

**OBJECTIVES**

1. To compare the effect of AF within-breeds (G_{WB}) to AF across-breeds (G_{AB}) on G in an admixed population, and to compare AF estimated from the genotyped versus base population
2. To compare single-step GBLUP validation reliabilities from G_{WB} and G_{AB}

**CONCLUSIONS**

- AF within breeds reduced breed differences in G, while AF across breeds increased G coefficients, markedly for distantly related animals
- G_{WB} with AF from the base populations was closer to A, which simplified the blending of these matrices
- Validation reliabilities were unaffected by AF used to construct G

**MATERIALS & METHODS**

- 4,106 bulls (1971-2006) with genotypes for 38,194 informative markers
- Deregressed proofs (DRP) for 2,816,745 cows
- Pedigree (n=4,624,453), used to estimate bulls' breed proportions

Modification of G with AF within breeds

- Regression of bull genotype on breed proportions was fitted to obtain AF
- \[ G_{WB} = ZZ'/m, \quad Z_{ij} = (u_{ij}-2p_{ij})/\sqrt{2p_{ij}(1-p_{ij})}, \]
  \[ m \] is the No. of markers; \( u_{ij} \) is 0, 1 or 2 copies of the 2nd allele and \( p_{ij} \) is expected mean AF

**Single-step GBLUP**

- Cow DRP were fitted as data, weighted by their effective record number
- A unified matrix combined G (i.e., G_{AB} or G_{WB}) and A
- Results were compared using Interbull GEBV validation test on young bulls

**RESULTS**

- Diagonal elements were smaller with G_{WB} versus G_{AB}
- G_{WB} coefficients were similar within and across breeds
- G_{WB} was more correlated (36%) with A than G_{AB} (16%) using AF from the base populations
- Reliabilities were 1-2% higher with G_{AB} than G_{WB}

**Validation reliabilities (R^2_{BV}) and regression coefficients (b_i) of breeding values**

<table>
<thead>
<tr>
<th>Method</th>
<th>Milk</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>G_{AB}</td>
<td>0.77</td>
<td>0.37</td>
</tr>
<tr>
<td>G_{WB}</td>
<td>0.75</td>
<td>0.36</td>
</tr>
</tbody>
</table>

**Base AF**

<table>
<thead>
<tr>
<th>Method</th>
<th>Milk</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>G_{AB}</td>
<td>0.76</td>
<td>0.37</td>
</tr>
<tr>
<td>G_{WB}</td>
<td>0.72</td>
<td>0.36</td>
</tr>
</tbody>
</table>